PROOF OF CONCEPT STUDIES FOR SURFACE BASED MECHANICAL PROPERTY RECONSTRUCTION

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INTRODUCTION: Digital Image-based Elasto-Tomography (DIET) is a proposed new imaging technique that takes advantage of the high elastic stiffness contrast between carcinoma and healthy breast tissue [1]. The intended system will utilize relatively inexpensive digital imaging sensors and computational algorithms to convert motion at the surface of the breast into a description of the elastic properties within the three-dimensional breast volume. Proof of concept studies are presented for the algorithm used to reconstruct the elastic properties.

METHODS: In the absence of clinical data, simple Finite Element (FE) models of a breast with a range of high stiffness inclusions were developed and surface motions were simulated though forward FE solution. The resulting surface motion was sampled and had random noise added to form a set of input motion data. The reconstructed elastic property distribution was computed iteratively using a Gauss-Newton based method.

Dual resolution techniques involving the use of two separate FE meshes were implemented to account for the reduced motion input data. A fine mesh closely aligned with the physical shape of the breast model supported the physics and mechanical motion of the model. The material property distribution of the reconstructive model was supported on a coarse mesh enclosing the fine mesh.

RESULTS: Figure 1 shows actual and reconstructed elastic modulus distributions for the simulation of a breast model with a spherical 5x stiffness inclusion. The reconstruction has identified the inclusion and its approximate stiffness. The result of a camera calibration study [2] confirmed that the 5% noise added to the input motion in this case was a conservative estimate for the motion noise in the final imaging system.

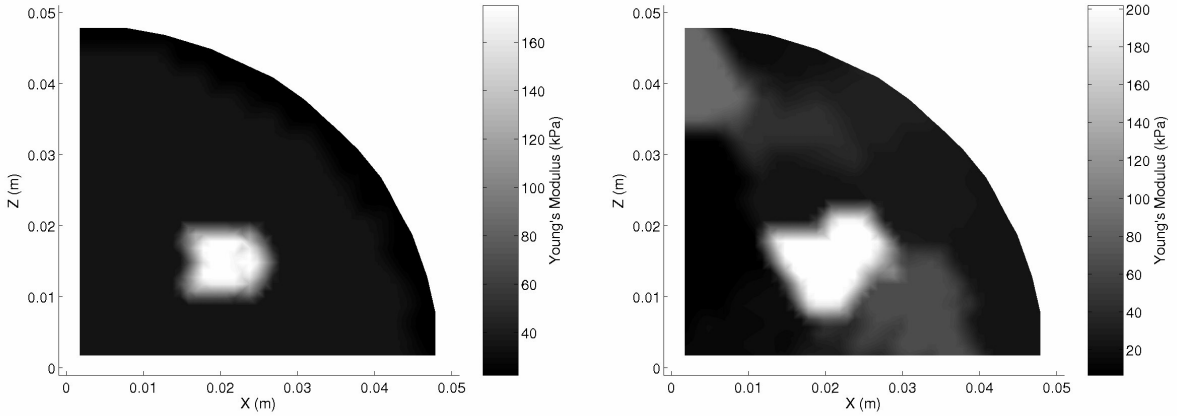

Fig. 1: Actual (left) and reconstructed (right) property distributions.

DISCUSSION & CONCLUSIONS: The aim of this preliminary study was to show that the reconstruction algorithm developed could successfully identify stiff inclusions in simulated breast models. High stiffness areas have been identified in several of the reconstruction cases in the presence of motion noise. Development of the reconstruction code and the reconstructive model will aid in image refinement.

REFERENCES:

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